

From Tool Steel to Coating: How Material & Coating Selection Work Together

In modern manufacturing, the synergy between tool steel selection and surface coatings is pivotal. The right combination enhances tool performance, extends service life, and ensures cost-efficiency. This whitepaper delves into the critical interplay between tool steel properties and coating technologies, emphasizing insights from industry tool steel leaders.

Understanding Tool Steel Fundamentals

1. Composition and Microstructure

Tool steels are engineered with specific alloying elements to achieve desired properties:

- Carbon (C): Provides hardness and strength.
- Chromium (Cr): Enhances hardenability and corrosion resistance.
- Molybdenum (Mo): Improves toughness and resistance to softening at high temperatures.
- Vanadium (V): Increases wear resistance and refines grain size.

The microstructure, influenced by heat treatment, determines the steel's performance characteristics.

2. Mechanical properties

Key properties influencing tool performance include:

- Hardness: Resistance to deformation.
- Toughness: Ability to absorb energy without fracturing.
- Wear resistance: The capacity to withstand surface degradation.
- Compressive strength: Resistance to deformation under load.

The balance between hardness and toughness is the clue to prevent premature tool failures.

The Role of Surface Coatings

Surface coatings, such as Physical Vapor Deposition (PVD) and Diamond-Like Carbon (DLC), are applied to enhance tool surface properties:

- Increased hardness: Coatings like TiN and AlCrN provide a hard surface layer.
- Reduced friction: DLC coatings offer low friction coefficients, minimizing wear.
- Thermal stability: Coatings maintain hardness at elevated temperatures.
- Corrosion resistance: Protects the substrate from chemical degradation.

Recent industry research demonstrates that selecting the optimal combination of substrate material and surface coating yields superior performance results. Factors such as coating adhesion, load-bearing capacity, and stress distribution play a critical role in how the tool behaves under operational conditions. When coating properties are matched to the substrate and application, users benefit from reduced downtime, higher precision, and better cost efficiency.

Application-Specific Considerations

1. Cold Work Applications

In operations like blanking and forming:

- Steel selection: Steels with high wear resistance and toughness are preferred.
- Coating choice: PVD coatings reduce friction and wear, extending tool life.

The role of matrix and carbide composition in steel is crucial to achieve the desired properties.

2. Hot Work Applications

For processes involving high temperatures:

- Steel selection: Steels with excellent thermal fatigue resistance are essential.
- Coating choice: Coatings that maintain hardness at elevated temperatures are crucial.

High-alloyed tool steels are designed to withstand such demanding conditions.

Conclusion

The integration of appropriate tool steel and surface coating is not a one-size-fits-all solution. It requires a comprehensive understanding of material properties, application demands, and operational conditions. By leveraging the expertise and research of industry leaders like Uddeholm and Böhler for tool steels and eifeler for coatings, manufacturers can make informed decisions to enhance tool performance and longevity.

About eifeler

Founded in Germany in 1983 and operating as part of the voestalpine High Performance Division within the voestalpine AG Group, eifeler is a leading provider of cutting-edge PVD coatings and services. With operations commencing in the NAM in 2021, and 30 production sites strategically located globally in major industrial hubs, our advanced PVD coatings optimize tool performance significantly. Renowned for our job coating services' reliability, we prioritize customer satisfaction through a customer-centric strategy, reinforcing our commitment to delivering superior surface engineering solutions.

For more information contact us at:

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